**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-2105997**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (CAICT)

**Title:** Email discussion summary for [98-bis-e][326] NR\_MIMO\_OTA

**Document for:** Information

# Introduction

*Contributions submitted to AI 8.1 NR MIMO OTA WI are captured in this email discussion.*

*In the RAN4#98e meeting, next steps of NR MIMO OTA WI were captured in the WF:*

*Next steps:*

* + *Further study the proper Channel model for FR1 2x2 MIMO OTA requirements*
  + *Discuss the pass/fail limit and reference figure of channel model validation*
  + *Further discuss testing parameters for requirements (e.g. Maximum downlink power for bands>3GHz)*
  + *Further discuss the Figure of Merit for FR1 and FR2*
  + *Measurement results of FR1 or FR2 UEs are encouraged for discussion*
  + *Channel model validation results for FR2 channel models are encourages*
  + *Analysis on MU evaluation of FR2 blocking issue*
  + *FR2 simulation results of UE performance are encouraged*

*List of candidate target of email discussion for 1st round and 2nd round*

* *1st round: agree TPs, discuss channel model validation, test parameters, FoM, simulation assumptions and other open issues for NR MIMO OTA.*
* *2nd round: make decision on open issues for NR MIMO OTA based on the decisions of 1st round.*

*Note: Given the meeting is only 7-day long and there is the RAN4 chair election, some changes in schedule are made compared to previous two-week e-meetings. Please pay close attention to the arrangements. The deadlines will be strictly enforced.*

# Topic #1: General and Testing methodologies

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104515 | vivo, CAICT, OPPO | Updated workplan of MIMO OTA WI  **Proposal**: Approve the proposed work plan for Rel-17 NR MIMO OTA WI. |
| R4- 2105170 | Huawei, HiSilicon | On channel model for FR1 2x2 MIMO OTA requirements  **Observation 1:** for the simulated NR FR1 2x2 configurations, CDL-C channel models have better performance than CDL-A, similar trend was observed in [4].  **Observation 2:** the required SNR @ TP 95% is from ~14.5 - 18.5 dB for the 4 simulated channel models. They are all within the feasible SNR range of FR1 MIMO OTA chamber.  **Observation 3:** regarding the SNR span inside every specific channel model from TP0% to TP100%, CDLC\_UMA is the “sharpest” one, with only ~1.5dB span compared to ~2.5dB of the other three. This might make the CDLC\_UMA not be the best choice from test granularity perspective. And CDLC\_UMAhas been selected for FR1 4x4 MIMO OTA.  **Observation 4:** no significant difference between “4k slot” and “2k slot” for the simulated n78& SCS30Khz.  **Proposal 1:** the priority order for FR1 2x2 channel model is CDL-A UMi = CDL-A UMa = CDL-C UMi > CDL-C UMa. |
| R4-2105041 | Samsung | Discussion on channel model and downlink power configuration  **Observation 1:** system downlink power availability is one aspect for consideration when selecting channel model.  **Proposal 1:** the path loss induced by different channel models need to be considered. It is preferred to choose the channel model which requires least downlink power. One possible candidate is to apply UMi CDL-C for both 2x2 and 4x4 MIMO. |
| R4-2107127 | Keysight Technologies | Reference Channel Emulation Curves  **Observation 1:** Definition of BS antenna element polarization is currently missing in TR 38.827  **Proposal 1**: Apply ****polarized antenna model with 45˚ slant angle for FR1 MIMO OTA and Ë polarized antenna model for FR2 MIMO OTA  **Proposal 2**: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the +/-45˚ slant angle for FR1 antenna model and 0˚/90˚ slant angle for FR2 antenna model |
| R4-2106902 | Spirent | Spatial Channel Model Validation Targets  **Proposal 1:** Adopt spatial channel model validation targets as presented. |
| R4-2106567 | OPPO | Consideration on Spatial Correlation with combined beam  **Observation 1**: DUT while performing MIMO OTA test receives wireless signals from all the clusters with both of the beam energy combined.  **Observation 2**: For CDL-C UMa, the coincided spatial correlation with combined beam approach reveals both of the two beams coincided well, accomplished with the PDP validation done separately for each beam.  **Proposal**: RAN4 should reconsider the baseline based on the combined beam approach to perform the spatial correlation validation. |
| R4-2105020 | CMCC | NR FR1 MIMO OTA Reference Spatial Correlation Curves based on Different Optimization Algorithm  **Observation 1:** If theoretical curve is not the objective function of optimization, simulation curve fit theoretical curve badly.  **Observation 2**: Different probe optimization algorithm makes different simulation result, and there are huge differences among them.  **Proposal:** Choose option #1 for spatial correlation reference curves. |
| R4-2104514 | vivo | Discussion on FR1 Power Validation procedure and compensation process  **Observation 1:** By using the average of 4 four orthogonal horizontal positions, the sum pattern is not flat vs angle, close to 0.5dB ripple is shown.  **Proposal 1**: If a horizontally polarized sleeve dipole is used for H component power validation, the horizontal positions should be more than 4. Recommended value is 16 to make sure the residual error is within 0.1 dB.  **Observation 2**: The reference antenna gain for dipole-based H-component power validation is the average of the theta gain pattern cut, which is missing in the spec.  **Proposal 2**: A note is needed in the power validation Measurement Procedure: “Note: in step 4, if horizontally polarized sleeve dipole is used, the reference gain correction should be the average of the theta gain pattern cut of the dipole.”  **Observation 3**: The base station setting for power validation should be identical to the measurement conditions, therefore the measured frequency needs to be the centre frequency of each band.  **Proposal 3**: The power validation should be performed per band, and the measured frequency is the centre frequency of each band.  **Proposal 4**: The power validation results should be considered as systematic offset of each band, which needs to be used to correct on the final sensitivity value to further reduce measurement uncertainty. |
| R4-2106569 | OPPO | Views on FR2 blocking issue  **Observation:** the conclusion can not be drawn that Probe 3 will not bring more blocking issue.  **Proposal:** the ripple test with Probe 3 activated can be considered to evaluate the measurement uncertainty of QoQZ and blocking effect. |
| R4-2107126 | Keysight | On Blocking MU for FR2 MIMO OTA  **Observation 1:** Blocking from Probe #1 is worse than from Probe #3.  **Observation 2:** The QoQZ validation procedure and MU element ‘Quality of quiet zone’ already captures the reflection/blocking from the positioning system.  **Observation 3**: 2 AoA RRM, which also leverages multiple probes simultaneously, is using the same QoQZ validation procedure with a single probe as FR2 MIMO OTA.  **Observation 4**: For systems that support both FR2 MIMO OTA and FR2 RRM testing, leveraging the same probe optimizes the QoQZ validation procedure.  **Observation 45**: The re-positioning concept has been incorporated in the FR2 MIMO OTA test cases and the QoQZ procedure, leveraged for all FR2 test methodologies, as optional approach.  **Observation 5**: The MTSUs for all FR2 test cases assume the re-positioning concept is applied, i.e., the optimized QoQZ MU must be used to determine the maximum acceptable MU.  **Proposal 1:** Consider the blocking issue properly captured for NR FR2 MIMO OTA. |
| R4-2107174 | CAICT | Views on MU evaluation of FR2 blocking issue  **Observation 1**: It is not clear whether the blocking effect of probe 3 is smaller than that of probe 1 based on the existing information.  **Proposal 1**: Whether the blocking issue of 3D-MPAC system has been properly covered by MU needs further analysis. |
| R4-2107293 | Huawei, HiSilicon | Discussion on bandwidth for NR FR2 MIMO OTA RMC  **Proposal 1**: We propose to at least use 200MHz CBW for 28GHz Bands. |
| R4-2104510 | vivo, CAICT | TP to TS38.151 v0.2.0 on FR1 Channel model |
| R4-2104511 | vivo, CAICT | TP to TS38.151 v0.2.0 on calibration and test procedure |
| R4-2104512  (reserved) | vivo | 3GPP TS 38.151 v0.3.0 |

## Open issues summary

### Sub-topic 1-1 General

**Issue 1-1: Updated Work Plan for NR MIMO OTA WI**

* Proposals
  + Proposal 1: Approve the proposed work plan for Rel-17 NR MIMO OTA WI in [R4-2104515].
* Recommended WF
  + Stabilize the updated Work Plan in the 1st round.

### Sub-topic 1-2 FR1 Channel model for 2x2

*Moderator: The discussion of FR1 channel model has lasted for several meetings, the group revised the previous agreement after further analysis on 4x4 channel model, and the RAN4#98e meeting conformed to adopt CDL-C UMa for FR1 4x4. In this meeting, proposal to further modify the 4x4 channel model is received in [R4-2105041]. However, in order to make progress, moderator hopes that we can focus on 2x2 channel model. It is not recommended to modify the 4x4 channel model again unless more measurement results are received to prove that the existing model is not suitable.*

**Issue 1-2: FR1 channel model for 2x2 MIMO**

* Proposal 1:
  + Option 1: CDL-A UMi (R4- 2105170)
  + Option 2: CDL-C Umi (R4- 2105170, R4-2105041)
  + Option 3: CDL-A Uma (R4- 2105170)
* Proposal 2: The path loss induced by different channel models need to be considered. It is preferred to choose the channel model which requires least downlink power.
* Recommended WF
  + TBA

### Sub-topic 1-3 Power validation procedure

**Issue 1-3-1: number of horizontal positions when using horizontally polarized sleeve dipole**

* Proposals
  + Proposal 1: If a horizontally polarized sleeve dipole is used for H component power validation, the horizontal positions should be more than 4. Recommended value is 16 to make sure the residual error is within 0.1 dB.
* Recommended WF
  + TBA.

**Issue 1-3-2: reference gain correction**

* Proposals
  + Proposal 1: A note is needed in the power validation Measurement Procedure: “Note: in step 4, if horizontally polarized sleeve dipole is used, the reference gain correction should be the average of the theta gain pattern cut of the dipole.”
* Recommended WF
  + TBA.

**Issue 1-3-3: Frequency for FR1 power validation**

* Proposals
  + Proposal 1: The power validation should be performed per band, and the measured frequency is the centre frequency of each band.
* Recommended WF
  + TBA.

**Issue 1-3-4: Compensation of power validation**

* Proposals
  + Proposal 1: The power validation results should be considered as systematic offset of each band, which needs to be used to correct on the final sensitivity value to further reduce measurement uncertainty.
* Recommended WF
  + TBA.

### Sub-topic 1-4 Channel model validation for FR1

*Power validation related topics are handled in sub-topic 1-3.*

**Issue 1-4-1: BS antenna element polarization for FR1**

* Proposals:
  + Proposal 1: Apply  polarized antenna model with 45˚ slant angle for FR1 MIMO OTA
  + Proposal 2: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the +/-45˚ slant angle for FR1 antenna model.
* Recommended WF
  + TBA

**Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**

* Proposals:
  + Option 1: beam specific approach (agreed as baseline in RAN4#98e)
  + Option 2: combined beams (R4-2106567)
* Recommended WF
  + TBA

**Issue 1-4-3: Reference figure for spatial correlation validation**

*Previous agreement on reference figure for channel model validation in RAN4#97e are listed as follow: [R4-2017585]*

* + Reference figure for channel model validation
    - Simulated curve (channel model with BS filtering effect) with limited number of probes (16 probes for FR1 and 6 probes for FR2) is agreed as a reference, to be added into the TR to determine pass fail limits.
    - Simulated curve (channel model with BS filtering effect) with infinite number of probes is optional to be added.

*Further analysis and proposals are presented in R4-2105020:*

* Proposals:
  + Option 1: Choose theoretical curve as reference
  + Option 2: Choose simulation curve as reference: If we choose any one simulation curve as reference, the details of probe optimization algorithm must be clear.
* Recommended WF
  + TBA

**Issue 1-4-4: Reference validation targets for FR1**

*Offline discussions among CE vendors are ongoing for alignment purposes.*

* Proposals: Reference PDP/Temporal correlation/Spatial correlation data for FR1 (CDL-C UMa and CDL-A UMi model)
  + Option 1: R4-2106902
  + Option 2: R4-2107127 *(* *note: a* *revision of R4-2107127 has been uploaded to draft folder to include additional CM validation curves)*
  + Option 3: Further study is needed.
* Recommended WF
  + TBA

### Sub-topic 1-5 Channel model validation for FR2

**Issue 1-5-1: BS antenna element polarization for FR2**

* Proposals
  + Proposal 1: Apply  polarized antenna model for FR2 MIMO OTA
  + Proposal 2: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the 0˚/90˚ slant angle for FR2 antenna model.
* Recommended WF
  + TBA.

**Issue 1-5-2: Reference validation targets for FR2**

* Proposals: Reference PDP/Temporal correlation/Spatial correlation data for FR2 (CDL-A InO and CDL-C UMi model)
  + Option 1: R4-2106902
  + Option 2: R4-2107127 *(The remaining reference PDP and autocorrelation data for FR2 models will be amended in this contribution before the start of # 98bis-e meeting. Additionally, updated spatial correlation reference curves will be provided in a revision of this contribution.)*
  + Option 3: Further study is needed
* Recommended WF
  + TBA

### Sub-topic 1-6 FR2 blocking issue

**Issue 1-6: FR2 Blocking issue**

* Proposals
  + Option 1:
    - Opt-1a: Whether the blocking issue of 3D-MPAC system has been properly covered by MU needs further analysis. [R4-2107174]
    - Opt-1b: the ripple test with Probe 3 activated can be considered to evaluate the measurement uncertainty of QoQZ and blocking effect. [R4-2106569]
  + Option 2: consider the blocking issue properly captured for NR FR2 MIMO OTA. [R4-2107126]
* Recommended WF
  + TBA.

### Sub-topic 1-7 FR2 MIMO OTA RMC

**Issue 1-7: FR2 MIMO OTA RMC**

*In RAN4#97e meeting, 16QAM RMC with 100MHz bandwidth is adopted as the only RMC for FR2 MIMO OTA.*

*In RAN4#98e, additional bandwidth of FR2 MIMO OTA RMC is proposed in [R4-2102729] and the agreement is to keep the previously agreed 100MHz.*

*In this meeting, FR2 MIMO OTA RMC with 200MHz is proposed and some feedbacks are provided in [R4-2107293].*

* Proposals
  + Proposal 1: at least use 200MHz CBW for 28GHz Bands
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

**Sub topic 1-1 General**

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| **Company** | **Comments** |
| OPPO | Support Proposal 1. |
| MediaTek | We are fine with Proposal 1 as a starting point, which reflects current WI and general Rel-17 time plan for core part and performance part well. However, just a general comment, if it is hard to achieve consensus for each checkpoint on time in the end, the exact deadline items of core part and performance part are still as shown in WID. |
| CAICT | We support the updated work plan.  To MTK: Of course, the overall deadline of core part and performance part should be consistent with that shown in WID, and current work plan also uses the same deadline as WID. |
| Huawei, HiSilicon | **Issue 1-1: Updated Work Plan for NR MIMO OTA WI**  For the work on “FR2 simulation of UE performance”, we may need to further refine it into: align the simulation assumption, UE/chipset vendors are provided with parameters that can emulate the gap between ideal propagation model and real chamber, provide simulation results based on the assumptions and parameters. |

**Sub topic 1-2 FR1 Channel model for 2x2**

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| **Company** | **Comments** |
| OPPO | We prefer Option 2. Actually, we believe CDL-C is more appropriate than CDL-A models. Not only because it matches with the base station features, but also two strongest beams in CDL-C models give UE more flexibility to design MIMO antenna than only one strongest beam in CDL-A models. |
| Keysight | Regarding Proposal 1: Prefer Option 1 as CM implementation/validation has progressed.  Regarding the results in R4-2105170: The correct beam direction is az: **-**7.27 deg and El: -10 deg for CDL-A Umi and CDL-C UMa for > 3.5 GHz. It seems that az: **+**7.27 was used in the simulations, which can also be seen in Figure 2. The results might be different if -7.27 beam direction was used.  Regarding Proposal 2: Our assumption is that 2-layer 2x2 test is not as sensitive to downlink power as 4x4 test. Therefore, the power criteria could be mainly applicable for 4x4 model selection. It would be best to have some empirical data to conclude if power is critical. |
| vivo | For Proposal 1, we prefer Option 2.  Besides, generally support P2 to consider the path loss, but this is only one of the aspects related to channel model characteristic. |
| Samsung: | Regarding Proposal 1, we prefer Option 2.  As a proponent of Proposal 2, we respect previous agreement on 4x4; for 2x2, we can see power is more critical for 2x2 than 4x4 from practical measurement in Figure 3 of R4-2101941. |
| CAICT | In principle, we support that the path loss induced by different channel models should be considered.  Although the simulation curves provided in R4-2105170 and R4-2101827 rank UMa CDL-C and UMi CDL-C models differently, the CDL-C model shows better performance than CDL-A model. A similar trend can also be seen from the practical test results of the CDL-C and CDL-A models. Considering that the maximum downlink power headroom of the 5G test equipment is limited, especially when the 64QAM is applied for 2x2 testing, it is reasonable to adopt CDL-C model (option 2) for FR1 2x2 testing.  However, given CE vendors have carried out a lot of work on channel model validation and reference curves based on CDL-A UMi for 2x2 MIMO, if RAN4 agree that the possible limited headroom for PRS-EPRE-MAX is acceptable, we are fine with option 1 to make progress on this topic. |
| Huawei, HiSilicon | For proposal 2, we are not clear why different channel model may induce different path loss, and have a rough guess that different channel models cause the probes to transmit different power signals, but this effect seems limited. We hope companies could provide some theoretical analysis or test results as reference for further analysis.  Thank keysight for pointing out the inconsistence in our R4-2105170. It is a typo in the text. We checked the source code, The beam direction used in figure1 simulation is actual az: -7.27 deg and El: 10 deg, instead of az: 7.27 deg and El: 10 described in our doc.  Regarding El: 10, our implementation is as below figure. Thank you very much.  cid:image007.png@01D7304D.226CF520 |
| Xiaomi | For proposal 1, we prefer option 2.  For proposal 2, we assumed this “path loss” wording might not be that appropriate as Huawei also pointed out that the channel model only apply time and phase difference. We assume this power difference caused by different channel models are from different power distribution as the receiver antenna is not full spherical covered. From this perspective, we agree that different channel model might have impact on the downlink received power. |
| Spirent | As CAICT wrote, the channel model is still moving because the assumptions to generate it are still moving (case in point the polarization assumption of the gNB array), therefore, conclusions based on channel models non-fully agreed may not be accurate.  As for the path loss, we agree with Huawei HiSilicon, and Xiaomi in that the wording needs to change, as the path loss is not given by the channel model. |

**Sub topic 1-3 Power validation procedure**

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| **Company** | **Comments** |
| vivo | Support the proposals in Issue 1-3-1, Issue 1-3-2, Issue 1-3-3 and Issue 1-3-4. |
| Huawei, HiSilicon | Issue 1-3-1: number of horizontal positions when using horizontally polarized sleeve dipole we fully understand the residual error can be reduced by increasing the horizontal positions to 16, with reduced error from 0.5 dB to 0.1 dB, but how much time the validation procedure will increase may need further discussion, which is better to make a balance between accuracy and validation time.  Issue 1-3-2: Support proposal 1.It is necessary to add this note when horizontally polarized sleeve dipole is used in case of reference gain correction.  Issue 1-3-3: Frequency for FR1 power validation As mentioned in Issue 1-3-1, the test time needs further consideration  Issue 1-3-4: Encourage interested companies to provide analysis for the gain of proposal 1. |

**Sub topic 1-4 Channel model validation for FR1**

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| **Company** | **Comments** |
| OPPO | **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  We support Option 2.  **Issue 1-4-3: Reference figure for spatial correlation validation**  Both Option 1 and Option 2 are acceptable. Considering the difficulty on presenting the probe optimization algorithm, Option 1 is actually feasible.  **Issue 1-4-4: Reference validation targets for FR1**  Option 3 is preferred. From current contributions (R4-2106902 & R4-2107127), obvious gaps can be found between two CE venders’ proposals. Although offline discussions are ongoing among CE venders, it is encouraged to clarify the process of getting the alignment from CE venders. |
| vivo | **Issue 1-4-2:** suggest to keep the beam specific approach as baseline.  **Issue 1-4-3:** given the simulation curve with BS filtering effect with limited number of probes has been agreed as reference, we would prefer not to revisit this conclusion. But we share similar interests to see an example probe optimization algorithm. |
| CMCC | **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  CMCC support Option 2 as our comments in RAN4 #98.  **Issue 1-4-3: Reference figure for spatial correlation validation**  It's difficult to get the alignment between CE venders, so we support Option1.  **Issue 1-4-4: Reference validation targets for FR1**  Option 3 is preferred. |
| CAICT | **Issue 1-4-3: Reference figure for spatial correlation validation**  Generally, we prefer to keep the previous agreement:   * Simulated curve (channel model with BS filtering effect) with limited number of probes (16 probes for FR1 and 6 probes for FR2) is agreed as a reference, to be added into the TR to determine pass fail limits. * Simulated curve (channel model with BS filtering effect) with infinite number of probes is optional to be added.   Considering the significant gap between different optimization algorithm raised in R4-2105020, it would be helpful if the objective function of optimization algorithm could be clarified.  **Issue 1-4-4: Reference validation targets for FR1**  Thanks to Keysight and Spirent for providing reference data for channel model verification. The alignment between the CE vendors will be highly appreciated.  **Clarification Question:**  Regarding the reference data and example figures, whether 40dB threshold for cluster power has been applied? |
| Qualcomm | **Issue 1-4-3: Reference figure for spatial correlation validation**  We are fine with either option 1 or option 2. If we go with option 1, the maximum and minimum limits should be provided.  **Issue 1-4-4: Reference validation targets for FR1**  Issue 1-4-4is pending on issue 1-4-3. How to come up a reference with two different proposals in option 1 and option 2? |
| Spirent | **Issue 1-4-1:**  We support option 1 (“X”)  **Issue 1-4-2:**  We support option 1, as this will simplify the validation and it will allow using the same channel model for validation and data throughput taking processes.  **Issue 1-4-3:**  We can support the use of the theoretical spatial correlation target.  Issue 1-4-4:  Here are revised curves for spatial correlation: |
| OPPO | **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  Per Spirent’s comment, the benefit of beam specific approach is “it will allow using the same channel model for validation and data throughput taking processes”. As discussed in #98-e, the channel models used in spatial correlation no matter with beam specific approach or combined beam approach, are exactly the same. The difference of the two approaches is hardware connection between the Base station emulator and Channel emulator, and this will not lead to channel model characteristics change. So the same channel model is used for validation and data throughput test no matter which validation approach is used.  **Issue 1-4-4: Reference validation targets for FR1**  **A clarification question to Spirent**: from the simulation curves, regarding to CDL-C UMa, why do beam 1 and beam 2 have the same curves when fc is lower than 2.45GHz, while they look different with fc over 3.6GHz? It can be found that the BS configuration is different (4x8 for lower frequency and 8x8 for higher frequency), but it seems not the root cause of the spatial correlation curve difference. |
| Huawei, HiSilicon | **Issue 1-4-1: BS antenna element polarization for FR1**  Fine with both proposal 1 and proposal 2. Implementing the +/-45˚ slant angle for FR1 antenna model by using polarization model-2 of section 7.3.2 of TR 38.901 is more general method than model-1.  **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  Support Option2. Combined beams approach is more flexible and time-saving but precise in testing.  **Issue 1-4-3: Reference figure for spatial correlation validation**  FFS. Encourage interested company to offer more simulation curve, and if the difference between curves is limited we would get a stable curve of channel model validation. Because different companies have different algorithms and model parameters, if the simulation curves differ a lot we would consider choosing theoretical curve as reference.  **Issue 1-4-4: Reference validation targets for FR1**  Option3. Prefer FFS. Make sure the parameters are consistent across different CE vendors. |

**Sub topic 1-5 Channel model validation for FR2**

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| **Company** | **Comments** |
| vivo | Regarding the channel model issue in 1-5-1 and 1-5-2, we would like to see aligned proposals from CE vendors. |
| CMCC | Issue 1-5-2: Reference validation targets for FR2  For PSP validation, the target PAS should be the theorical one which can be calculated as section 2.1.3 in R4-1706668. |
| CAICT | **Issue 1-5-2: Reference validation targets for FR2**  See comments in issue 1-4-4. |
| Huawei, HiSilicon | We support to use model 2, but we have two questions on applying  polarized antenna model for FR2 MIMO OTA(or implementing the 0˚/90˚ slant angle):  1. What is the mapping relationship between the BS antenna element polarization and the probes’ polarization? Could it be considered as one-to-one mapping ?   |  |  |  | | --- | --- | --- | |  | Probe | BS | | 1 |  |  | | 2 |  |  |   2. Does different polarization () implementation affect the test results? If it does, the polarization may need to align with BS implementation. We would like company to provide technical analysis on the impacting by using different polarization before we have conclusion. |
| Spirent | **Issue 1-5-1:**  We also think that the gNB polarization model must match what is being done by infrastructure providers. We invite companies that produce infrastructure to provide feedback. |

**Sub topic 1-6 FR2 blocking issue**

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| **Company** | **Comments** |
| OPPO | We support Option 1. To my understanding, the question to be answered is whether the Probe 3 will bring more MU, and this needs more analysis or validation. |
| Keysight | Support Option 2. |
| vivo | Option 1. Given the blocking issue has direct impacts on the quality of the implemented channel model within the test zone, but this is not validated/presented by channel model validation process, so we believe the blocking issue should be further studied. |
| CMCC | Support Option 1. |
| CAICT | We support option 1.  Comparing the position of Probe#1 and Probe#3, although Probe#3 can be further away from the support structure in azimuthal orientation, it’s hard to say which Probe may experience more blocking since Probe#3 is the only probe located in the lower hemisphere. Moreover, the weight of each probe is unknown and therefore it is not easy to evaluate whether the QoQZ testing using Probe#1 can include the blocking impact on Probe#3.  According to the information we have, we think no obvious conclusion can be reached at this stage. Further analysis is needed before we come to the conclusion. |
| Qualcomm | Support option 1. |
| Xiaomi | Support option 1. |
| ETS-Lindgren | We need to be careful about nomenclature. At the interference position, e.g. Test Point 36, *all* probes are in the lower hemisphere of the DUT coordinate system. The issue of blockage is primarily one of the test system design, although it’s hard to envision any test system that wouldn’t block probe 1 at theta = 180. However, for any position in the lower hemisphere, it should be expected that there is always *some* amount of support structure that blocks a portion of the lower hemisphere even if the positioning system components (e.g. phi axis axle and column) are all outside the field of view, since some amount of support must extend into the QZ to the DUT. That could be just as bad as the presumably worst-case condition of blockage by the phi-axis axle region.  Note however that there is a significant problem with the re-positioning concept unless it is made mandatory. That’s because unlike the SISO tests, the cluster definition is asymmetric and thus flipping the DUT over flips the cluster over in the DUT coordinate system. Thus, the full spherical vs. two hemisphere re-positioning approach are two completely different tests in the lower hemisphere of the DUT.  We’d agree with Option 1a that more work is needed, but that it goes beyond just the MU discussion. |

**Sub topic 1-7 FR2 MIMO OTA RMC**

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| **Company** | **Comments** |
| Keysight | Support Proposal 1 |
| vivo | Consider existing commercial Channel model emulator in each test lab, we suggest to keep 100MHz for FR2 and conclude the discussion of this topic. |
| MediaTek | We are okay to add 200MHz CBW for 28GHz. However, we prefer to finalize 100MHz CBW details as first priority. |
| Samsung | RMC parameter is a trade-off, that’s why higher modulation than 16QAM is not used. Similarly, 100MHz BW is also the same situation. It is not a good choice to make the RMC parameters divergent by adopting 200MHz for 28GHz and 100MHz for 39GHz. It is better to keep previous agreement. |
| CAICT | Is the proposal to replace 100MHz CBW with 200MHz CBW, or add additional performance requirements with 200MHz CBW? |
| Huawei, HiSilicon | We support to use 200MHz CBW for 28GHz. Considering we already agree 16QAM as the RMC parameter, the reachable SNR in the chamber for 200MHz is enough for 16QAM demodulation. Meanwhile, 200MHz is the mandatory channel bandwidth in RAN2 spec, in which ‘1’ should be set for 200MHz. It is reasonable to introduce 200MHz RMC for at least 28GHz Band. |
| Qualcomm | We have concern to use 200MHz CBW for FR2. The achievable SNR calculated in the paper doesn’t take the impact of fading channel, i.e., fading crest factor, into account. In RAN5 discussion, about 10dB power backoff is considered. Therefore, with 200MHz CBW, it will lead to more testing points are outage. If we look at the CBW for FR1 MIMO OTA, to avoid the lack of power issues, 40MHz CBW is selected rather than 100MHz. |
| Xiaomi | We agree with Samsung’s comment that the RMC is a choice and to keep the previous agreement on 100MHz. |
| OPPO | We support keeping 100MHz CBW for FR2. Besides considerations of existing commercial channel model emulator in labs, using the same RMC parameters for different FR2 bands, and achievable SNR, there is another factor taking into account. The industry status is that the earliest commercial chipset supporting FR2 200 CBW will be launched in the first half of 2022. In this case, no measurement results can be gathered from labs based on commercial devices before that time. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2104510  (TP) | Keysight: we prefer alternate language of the beamforming characteristics and will be working with authors offline. Additionally, the X2V concept should be further clarified in this TP. |
| vivo: we are fine to further refine the wording about beamforming characteristic. |
|  |
| R4-2104511  (TP) | Samsung: we support the text proposal in test procedure |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic 1-1 General** | **Issue 1-1: Updated Work Plan for NR MIMO OTA WI**  *Tentative agreements:*   * Further refine the detailed work plan on “FR2 simulation of UE performance” based on the 1st round comments. The rest of work plan in R4-2104515 is endorsed.   *Recommendations for 2nd round:*  • Approve the updated work plan which will be revised based on the above agreements. |
| **Sub-topic 1-2 FR1 channel model for 2x2** | **Issue 1-2: FR1 channel model for 2x2 MIMO**  *Regarding proposal 1, 7 companies shared views on this issue. 5 companies support option 2, 2 companies support option 1, 1 company pointed out that the conclusion based on channel models non-fully agreed may not be accurate.*  *Tentative agreements:*   * The impact of different channel models on the downlink received power need to be considered.   *Candidate options:*   * Option 1: CDL-A UMi * Option 2: CDL-C UMi   *Recommendations for 2nd round:*  Further discuss the suitable channel model for 2x2 testing. |
| **Sub-topic 1-3 Power validation procedure** | **Issue 1-3-1: number of horizontal positions when using horizontally polarized sleeve dipole**  *Recommendations for 2nd round:*  Further discuss how much time will be added to the validation procedure by increasing the horizontal positions and try to make a balance between accuracy and validation time.  **Issue 1-3-2: reference gain correction**  *Agreements:*   * + A note is needed in the power validation Measurement Procedure: “Note: in step 4, if horizontally polarized sleeve dipole is used, the reference gain correction should be the average of the theta gain pattern cut of the dipole.”   *Recommendations for 2nd round:*  *None.*  **Issue 1-3-3: Frequency for FR1 power validation**  *Recommendations for 2nd round:*  Further discuss on this topic.  **Issue 1-3-4: Compensation of power validation**  *Recommendations for 2nd round:*  Further discuss on this topic. Encourage interested companies to provide analysis for the gain of proposal 1. |
| **Sub-topic 1-4 channel model validation for FR1** | **Issue 1-4-1: BS antenna element polarization for FR1**  *No objections to proposal 1 and proposal 2 were received.*  *Agreements:*   * + Proposal 1: Apply  polarized antenna model with 45˚ slant angle for FR1 MIMO OTA   + Proposal 2: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the +/-45˚ slant angle for FR1 antenna model.   *Recommendations for 2nd round:*  *None.*  **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  *5 companies shared views on this issue. 2 companies (vivo, Spirent) support option 1, 3 companies (OPPO, CMCC, Huawei) support option 2.*  *Candidate options:*   * + Option 1: beam specific approach (agreed as baseline in RAN4#98e)   + Option 2: combined beams (R4-2106567)   *Recommendations for 2nd round:*  Further discuss on this topic. Agreement can be captured in the WF.  **Issue 1-4-3: Reference figure for spatial correlation validation**  *Companies hold different views on this issue, and some companies can accept either option 1 or option 2.*  *Candidate options:*   * + Option 1: Choose theoretical curve as reference. (OPPO, CMCC, QC, Spirent)   + Option 2: Choose simulation curve as reference: (OPPO, vivo, CAICT, QC, Spirent)   + Option 3: FFS (Huawei)   *Recommendations for 2nd round:*  Further discuss on this topic. Given simulation curve is the agreement in the last meeting, sufficient benefits should be presented before other options are selected.  **Issue 1-4-4: Reference validation targets for FR1**  *Offline discussions among CE vendors are ongoing for alignment purposes.* *All companies that have shared views on this topic support option 3, i.e., further study is needed.*  *Agreements:*   * Further study on the reference validation targets for FR1 is needed.   *Recommendations for 2nd round:*  Further discuss on this topic. |
| **Sub-topic 1-5 channel model validation for FR2** | **Issue 1-5-1: BS antenna element polarization for FR2**  *No clear support or opposition was received.*  *Recommendations for 2nd round:*  *Confirm if Proposal 1 and Proposal 2 are agreeable. Feedbacks from infrastructure providers are encouraged.*  **Issue 1-5-2: Reference validation targets for FR2**  *Agreements:*   * Further study on the reference validation targets for FR2 is needed.   *Recommendations for 2nd round:*  Further discuss on this topic. |
| **Sub-topic 1-6 FR2 blocking issue** | **Issue 1-6: FR2 Blocking issue**  *8 companies shared views on this issue. 7 companies support option 1 and 1 company support option 2. Therefore, the recommended agreement would be:*  *Agreements:*   * The blocking issue of 3D-MPAC system is not properly presented, more study is needed.   *Recommendations for 2nd round:*  Further discuss how to evaluate the blocking issue in 3D-MPAC system. |
| **Sub-topic 1-7 FR2 MIMO OTA RMC** | **Issue 1-7: FR2 MIMO OTA RMC**  *9 companies shared views on this topic, 7 companies support keeping the previously agreed 100MHz CBW, 1 company support 200MHz CBW, and 1 company can accept 200MHz CBW but prefer to finalize 100MHz CBW as first priority.*  *Considering that the discussion has been going on for two meetings, but no clear support on 200MHz CBW is received except for the source company, therefore the recommended agreement would be:*   * *Keep the previously agreed 100MHz CBW for FR2 and conclude the discussion of this topic.*   *Recommendations for 2nd round:*  Confirm the agreement on keeping 100MHz for FR2 and conclude the discussion of this topic. |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

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| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

### Sub-topic 1-1 General

**Issue 1-1: Updated Work Plan for NR MIMO OTA WI**

*Tentative agreements:*

* Further refine the detailed work plan on “FR2 simulation of UE performance” based on the 1st round comments. The rest of work plan in R4-2104515 is endorsed.

*Recommendations for 2nd round:*

• Approve the updated work plan which will be revised based on the above agreements.

### Sub-topic 1-2 FR1 Channel model for 2x2

**Issue 1-2: FR1 channel model for 2x2 MIMO**

*Candidate options:*

* + Option 1: CDL-A UMi
  + Option 2: CDL-C UMi

*Recommendations for 2nd round:*

Further discuss the suitable channel model for 2x2 testing.

### Sub-topic 1-3 Power validation procedure

**Issue 1-3-1: number of horizontal positions when using horizontally polarized sleeve dipole**

* Proposals
  + Proposal 1: If a horizontally polarized sleeve dipole is used for H component power validation, the horizontal positions should be more than 4. Recommended value is 16 to make sure the residual error is within 0.1 dB.

*Recommendations for 2nd round:*

Further discuss how much time will be added to the validation procedure by increasing the horizontal positions and try to make a balance between accuracy and validation time.

**Issue 1-3-3: Frequency for FR1 power validation**

* Proposals
  + Proposal 1: The power validation should be performed per band, and the measured frequency is the centre frequency of each band.

*Recommendations for 2nd round:*

Further discuss on this topic.

**Issue 1-3-4: Compensation of power validation**

* Proposals
  + Proposal 1: The power validation results should be considered as systematic offset of each band, which needs to be used to correct on the final sensitivity value to further reduce measurement uncertainty.

*Recommendations for 2nd round:*

Further discuss on this topic. Encourage interested companies to provide analysis for the gain of proposal 1.

### Sub-topic 1-4 Channel model validation for FR1

**Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**

*Candidate options:*

* + Option 1: beam specific approach (agreed as baseline in RAN4#98e)
  + Option 2: combined beams (R4-2106567)

*Recommendations for 2nd round:*

Further discuss on this topic. Agreement can be captured in the WF.

**Issue 1-4-3: Reference figure for spatial correlation validation**

*Candidate options:*

* + Option 1: Choose theoretical curve as reference. (OPPO, CMCC, QC, Spirent)
  + Option 2: Choose simulation curve as reference: (OPPO, vivo, CAICT, QC, Spirent)
  + Option 3: FFS (Huawei)

*Recommendations for 2nd round:*

Further discuss on this topic. Given simulation curve is the agreement in the last meeting, sufficient benefits should be presented before other options are selected.

**Issue 1-4-4: Reference validation targets for FR1**

*Offline discussions among CE vendors are ongoing for alignment purposes.* *All companies that have shared views on this topic support option 3, i.e., further study is needed.*

*Recommendations for 2nd round:*

Further discuss on this topic.

### Sub-topic 1-5 Channel model validation for FR2

**Issue 1-5-1: BS antenna element polarization for FR2**

*No clear support or opposition was received in 1st round.*

* Proposals
  + Proposal 1: Apply  polarized antenna model for FR2 MIMO OTA
  + Proposal 2: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the 0˚/90˚ slant angle for FR2 antenna model.

*Recommendations for 2nd round:*

*Confirm if Proposal 1 and Proposal 2 are agreeable. Feedbacks from infrastructure providers are encouraged.*

**Issue 1-5-2: Reference validation targets for FR2**

*Recommendations for 2nd round:*

Further discuss on this topic.

### Sub-topic 1-6 FR2 blocking issue

**Issue 1-6: FR2 Blocking issue**

*Recommendations for 2nd round:*

Further discuss how to evaluate the blocking issue in 3D-MPAC system.

**Sub topic 1-1 General**

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| **Company** | **Comments** |
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**Sub topic 1-2 FR1 Channel model for 2x2**

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| **Company** | **Comments** |
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**Sub topic 1-3 Power validation procedure**

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| **Company** | **Comments** |
| MVG | Issue 1-3-3: We do propose to perform power validation for the frequencies reported in TR 38.827, table 7.4.1-1. Those are the agreed frequencies for which channel models validation and QoQZ shall be performed. |
| Vivo | Given some misunderstanding raised, we would like to further elaborate the issue of the power validation procedure in the current MIMO OTA spec:  **Issue 1-3-1: number of horizontal positions when using horizontally polarized sleeve dipole**  Indeed, increasing the average position from 4 to 16 will optimize the power validation accuracy but also increase the H power measurement time. However, the power measurement is a fast spectrum scan with large RBW, the test is very quick even 100 averaging is used:  Table C.3.6-1: Spectrum analyzer settings for power validation measurements   | Item | Unit | Value | | --- | --- | --- | | Center frequency | MHz | Downlink center frequency  in Table C.3.1-1 | | Integrated Channel Span | Hz | 20MHz | | RBW | Hz | 30 kHz | | VBW | Hz | ≥10MHz | | Number of points |  | ≥400 | | Averaging |  | ≥100 | | Detector |  | RMS |   Typically, the measurement could be several minutes for 4 orthogonal-horizontal-positions approach, increased to 16, it would take more than 20 minutes. We would encourage interested companies to check the actual test time and further discussed.  The main intention is that we think specifically limit the number to be 4 would not be a proper way to go, especially considering that the validation error would be 0.5dB high, and the real power in the test zone would have direct impact on the final MIMO OTA performance (I would further elaborate it in Issue 1-3-4, explain why we need the compensation). We suggest the number should be changed to “at least 4”, then lab can do more accurate test with more averaging position if they want to take that time~  **Issue 1-3-3: Frequency for FR1 power validation**  We want to elaborate why the frequency for power validation in the spec is a mistake.   1. For SISO or MIMO quiet zone validation (ripple test), selecting a set of frequency for validation to present the quality of all the bands within the same set of frequency range is a typical way.     Figure in CTIA SISO OTA spec   1. But for LTE MIMO channel validation, the traditional way in the industry is to do the validation per band with the center frequency of each band.     Figure in TR 37.977 LTE MIMO OTA    Figure in CTIA MIMO OTA   1. When we drafting the TR38.827 for NR, we found that it would be time consuming if we validate the channel model per-band, given NR has so many bands. Then I proposed to select typical frequency to perform the channel model validation for saving time, similar to Quality of Quite zone, and that’s the reason why the defined set of frequency is used for both chamber ripple test and channel model validation in 38.827.     Figure in TR38.827  This is a good approach to validate the system channel model to cover low-to-high bands and also reduce the measurement time.  However, these test frequencies in the above table are OK for PDP, Doppler, Spatial correlation, and XPR, but are unavailable for power validation. The reason is that: For PDP, Doppler, Spatial correlation, XPR validation, the signal source is a VNA or CW signal generator, so there is no problem to just validate the above frequencies. But for Power validation, the signal source is the gNodB emulator, which should be set with the RMC each band same as that for MIMO OTA measurement (bandwidth, centre frequency, modulation, etc), in consequence the spectrum analyzer should has the same frequency. Looking at the above table, for example, 1880MHz is not the centre frequency of any NR band which can not be tested for Power validation!    Power validation procedure in TR38.827  This is the reason why we need to *Only* change power validation to per-band approach, and keep others (PDP, Doppler, Spatial correlation, XPR) using the same frequency as quite zone ripple test.  **Issue 1-3-4: Compensation of power validation**  Although there is calibration procedure for MIMO OTA, the real power after channel modeling algorithm in the system is still different from that calculated and reported by channel emulator. For example, the target DL power is -80dBm/15kHz, but the real DL power in the center of test zone may be -82dBm/15 kHz, then there will be a risk that some UE orientations may fail 90%TP criterion, and the measured TRMS is always 2dB worse than the real UE performance. In contrast, if the real DL power is always 2dB higher, -78dBm/15kHz, then the test lab would always get better UE performance.  This power gap can be found and measured by power validation, and the power offset should be corrected and compensated on the DL power, to make sure the final results are real UE performance. This power compensation approach is also adopted by CTIA LTE MIMO OTA.  *In summary, after power validation, we can get the power error/offset of each band, and the value should be corrected/compensated on the DL power, to get real UE performance.* |
| MVG | Issue 1-3-3: we are sorry our comment was creating some confusion. We were pointing to table 7.4.1-1 just to indicate the philosophy we used there, grouping all the bands in several sub-bands. It was clear to us that the frequencies in the table will not correspond to any channel/frequency for any NR operating bands even though it will be just a matter of tweaking that frequency a bit. We still believe that the “grouping” approach is feasible and technically correct approach. |

**Sub topic 1-4 Channel model validation for FR1**

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| **Company** | **Comments** |
| Keysight | **Issue 1-4-4: Reference validation targets for FR1**  Offline progress between KS and Spirent on aligning the simulation curves was made. More time is needed and it is suggested for KS and Spirent to further collaborate offline to align before RAN4#99-e. Decisions on Issue 1-2 and Issue 1-4-2 needed to progress and finalize the targets by next meeting. |
| Keysight | **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  Support combined beam validation for spatial correlation. Combined beam validation is more time efficient since full spatial correlation validation can be performed with the combined two or four port measurements. The combined beam validation for spatial correlation can be accepted if PDP validation is done separately for each beam in this case.  **Issue 1-4-3: Reference figure for spatial correlation validation**  Support simulated curve as a reference, because the 16 probe implementation result is not well aligned with the theoretical in all cases. Theoretical reference could lead into loose acceptance limits, which would possibly allow bad OTA implementations to pass the validation test. The alignment between CE vendors can provide closer match between the vendor specific simulated curves than what can be achieved between the theoretical and simulated. |
| Spirent | **Issue 1-4-2**  Answers to OPPO from round 1: We see a problem when there is a specific BS emulator -Channel Emulator connection needed for validation. In fact, for validation, the BS emulator is not even present. The beam specific validation approach will remove the need for any assumption as to how the BS emulator and Channel Emulator are connected.  **Issue 1-4-4**  Answers to OPPO from round 1: For frequencies < 2500 MHz, 38.827 specifies a 4x8 BS array, and above 2500 MHz an 8x8 array.  At the lower frequency, the beams are wider and the 2nd strongest beam is pointed at the same clusters as the strongest beam for CDL-C.  The PDP is also very similar and this produces nearly identical curves in some cases.  At the higher frequencies the strongest and 2nd strongest beams point to different clusters and the results are very different.  We are looking at all of the curves and we are working off-line with other channel emulator vendors to understand possible differences.  Answers to CAICT from round 1: All the target curves we have presented include the 40dB threshold. |

**Sub topic 1-5 Channel model validation for FR2**

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| **Company** | **Comments** |
| Spirent | **Issue 1-5-1**  We need to get input from gNB vendors as to what polarization model to use for FR2 (“**X**” or “**+**”).  **Issue 1-5-2:**  We are working with other CE vendors to finalize the assumptions for FR1, and we will move to FR2 when done. |

**Sub topic 1-6 FR2 blocking issue**

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| **Company** | **Comments** |
| Keysight | A potential three-step simulation/measurement approach to quantify the blocking issue could be as follows:   1. Determine S21 for No Blocking Reference    1. Positioner AZ/Theta=0    2. Reference antenna pointing along z direction directly at Probe 1 2. Determine S21 to study Blocking of Probe 1    1. Positioner AZ/Theta=161.7deg    2. Reference antenna pointing direction directly at Probe 1 3. Determine S21 to study Blocking of Probe 3    1. Positioner AZ/Theta=161.7deg    2. Reference antenna pointing direction directly at Probe 3     Feedback to ETS-L regarding comment (“cluster definition is asymmetric and thus flipping the DUT over flips the cluster over in the DUT coordinate system”):  We do not believe that this statement is correct in general and would like to illustrate this below. Here, we took a look at test point #30 which is in the 2nd hemisphere (theta > 90deg), i.e., this is where the re-positioning approach is applicable.   |  |  |  | | --- | --- | --- | | **Test Point Number** | **Theta [deg]** | **Phi [deg]** | | 1 | 0.0 | 0.0 | | 30 | 128.8 | 91.3 | | 36 | 161.7 | 59.1 |   When a tablet is placed with Alignment Option 1 – Orientation 1 into the system and adjust the Motor/DUT coordinates (180o≤AZ≤180o,180o≤Roll≤180o) for Test Point #30    we get the following placement of the UE. Notice that the positioner is in the hemisphere with z>0 and introduces some blocking, i.e., the re-positioning concept is not applied.    When we place the Tablet into the system with Alignment Option 1 – Orientation 2 (Option 1) and adjust the Motor coordinates (180o≤AZ≤180o,180o≤Roll≤180o) so that the DUT coordinates are matched with Test Point #30    we get the following placement of the UE.    Notice that the positioner is in the hemisphere with z<0 and no longer introduces blocking which is the basis of the re-positioning concept and that the DUT placement with respect to the probes is the same as for non-repositioning concept (Alignment Option 1 – Orientation 1). The same observation can be made with Alignment Option 1 – Orientation 2 (Option 2)  We therefore do not agree with the general “cluster definition is asymmetric and thus flipping the DUT over flips the cluster over in the DUT coordinate system” statement.  At the same time, the ambiguities we have highlighted earlier [R4-2006743] still apply. For instance, for Test Point #30, the following motor coordinates yield the same DUT coordinates    but the DUT placement with respect to the probes is the not the same anymore. |

# Topic #2: Performance requirements

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4- 2105169 | Huawei, HiSilicon | On remaining open issues of testing parameters for performance  **Observation 1:** according to section TS 37.144 [3] section 8.1.1, maximum downlink power PRS-EPRE-MAX is defined as -80 dBm/15 kHz for LTE UE MIMO OTA.  **Observation 2**: according to TS 36.101 and TS 38.101-1, the sensitivity requirements for LTE and NR are similar for same 2 Rx.  **Observation 3**: according to TS 38.101-1, the sensitivity for bands >3GHz is slightly higher than <3GHz due to higher IL (Insertion Loss, 1dB [5]).  **Observation 4**: in addition to rank=2 as LTE, NR MIMO OTA requires the test of Rank=4 MIMO which requires higher SNR.  **Proposal 1**: for bands>3GHz, for both 10MHz and 40MHz bandwidth, Maximum downlink power PRS-EPRE-MAX should be at least -80 dBm/15 kHz (-77dBm/30kHz), i.e. same as <3GHz. The preferred value is -79dBm/15kHz (-76dBm/30kHz), taking into account the higher insertion loss.  **Proposal 2**: For FR1 MIMO OTA performance requirements, adopt 2 of total 12 as additional restriction of Pmode for 10MHz and 40MHz CHBW  For FR2 MIMO OTA performance requirements, keep the agreement of using “the average over top 50%” as FR2 requirement metric. And the number of missing points should not exceed 18. |
| R4-2105041 | Samsung | Discussion on channel model and downlink power configuration  **Observation 2:** standardized maximum downlink power configuration is the precondition for determination of other figure of merits.  **Proposal 2:** specify maximum downlink power configuration firstly and then determine other related figure of merits. It is encouraged to define the maximum downlink power based on practical measurement for FR1, and to further study how to specify maximum downlink power configuration for FR2. |
| R4-2104513 | vivo | Discussion on FR2 FoM  **Observation 1**: For DUT1 with good MIMO OTA performance, the substitution approach does not have much impact (~0.3dB) on the Power at 50% percentile value and final MASC performance (~0.2dB).  **Observation 2**: For “DUT2- Nominal” and “DUT3-Bad”, similar trend with “DUT1-Good” is observed.  **Observation 3**: For DUT4 with large gain drop from peak to 50%-tile value, the MASC difference is about 0.9dB.  **Observation 4**: The device has large gain drop among different directions would be impacted greater by the substitution approach with more missing points (e.g. ~2.2dB for DUT4 with 9 points missing condition).  **Proposal 1**: The CDF curve should adopt substitution approach, the final MASC is the average of the top 18 points.  **Proposal 2**: Similar to FR1 FoM, RAN4 should define an additional criterion of the number of missing points (i.e. directions that can not reach target throughput even at the maximum downlink power supported by the system) for FR2 MIMO OTA. |
| R4-2106272 | CAICT | Views on how to treat the missing points for FR2 FoM  **Observation 1**: In the case that the number of missing points does not exceed 50% of the total number of test points (i.e., up to 18 missing points), the MASC calculation result will not be affected by the missing points.  **Observation 2**: It is possible for the EUT to obtain a good MASC value even when there are many missing test points, but this MASC value does not reflect the FR2 MIMO OTA performance of the EUT accurately under this condition.  **Proposal 1**: There is no need to consider the impact of orientations those cannot reach target outage TP for defining FR2 MASC.  **Proposal 2**: For FR2 MIMO OTA performance requirement, additional criterion on how many missing points is permitted around the sphere should be defined.  **Note**: Proposal 1 and proposal 2 should be considered in package, which means proposal 1 cannot be applied separately without Proposal 2.  **Observation 3**: For FR1 MIMO OTA performance requirement, the EUT must meet 70% TP in 11 of total 12 azimuthal orientations, i.e., 3 missing points are permitted out of a total of 36 test points with outage point of TP@70%.  **Observation 4**: For FR1 MIMO OTA performance requirement, the EUT must meet 90% TP in [TBD] of total 12 azimuthal orientations, i.e., TP@90% is also regarded as an additional FoM and the maximum number of missing points need further studied.  **Proposal 3**: For outage TP@70%, similar principle for additional criterions can be applied to FR2 MIMO OTA, and the restriction on the number of missing points can be relaxed on the basis of FR1 (FR1: 3 of total 36 test points).  **Proposal 4**: TP@90% is also regarded as an additional FoM and the maximum number of missing points is FFS.  **Proposal 5:** Further check the final number of missing points allowed for FR2 MIMO OTA after the testing parameter are fully defined. |
| R4-2106568 | OPPO | FoM for FR2  **Proposal:** The MASC is derived from averaging the top 18 values of total 36 test points. |
| R4-2107116 | Qualcomm | Discussion on FR2 MIMO OTA performance requirements  **Proposal 1**: RAN4 to agree the revision on the definition of MACS from TS 38.151 as [5].  **Observation 1**: It is not clear how to emulate PSP in the simulation since PSP is one of the criteria for channel validation that depends on several factors.  **Observation 2**: In addition to PSP, there are other criterion such as PDP, Doppler, etc. for channel validation that will also have impact on the simulation results.  **Proposal 2:** RAN4 should start the simulation campaign to calibrate the simulation platform with the channel model assumptions specified in TR38.827 as the first step.  **Proposal 3:** Companies should analyse the impact on the channel validation criterion such as PSP, PDP, doppler etc., and performance difference caused by the channel parameters variation such as AoA/ZoA, PAS, power, delay, etc. those explicitly reflect in the channel model parameters.  **Proposal 4**: The input on variation range of channel model parameters such as AoA/ZoA, PAS, power, delay, etc. impacting by 6 probes should be provided by TE/CE vendors.  Proposal 5: we propose to use the following assumptions for simulation campaign, i.e., using the channel parameters specified TR38.827 as the starting point:  • UE antenna array: two panels 2x2 patches (option 1)  • UE antenna parameters and Beam forming: Follow TR 38.803 (option 1)  • Polarization alignment: polarization aligned between UE and TE (option 1) |
| R4-2107294 | Huawei, HiSilicon | Discussion on FR2 MIMO OTA simulation  **Proposal 1:** 40dB threshold does not affect UE throughput performance with CDL-A InO channel model for FR2.  **Observation 1**: The power distribution of clusters in CDL-A InO channel model is too concentrated, causing the three clusters at the same location to have very high power, and other clusters have almost no impact on UE throughput, which makes the CDL-A InO channel model look like the TDL channel model without angular spread.  **Proposal 2**: Further discuss the necessity of CDL-A InO channel model for FR2 MIMO-OTA.  **Proposal 3**: CE vender are welcome to publish their probe weights and align them to reduce MU for FR2 MIMO OTA. |
| R4-2107363 | Qualcomm Incorporated | TP to TS38.151: revision on definition for MASC |
| R4-2107295 | Huawei, HiSilicon | TP to 38.151 on MIMO Average Spherical Coverage |

## Open issues summary

### Sub-topic 2-1 Maximum downlink RS-EPRE

*The agreement of test parameters for FR1 requirements are shown as below:*

*In RAN4#97e:*

* + - For band frequency <3GHz, the maximum downlink RS-ERPE should be -80dBm/15kHz for 10MHz gNB setting
      * Further study the maximum downlink RS-EPRE for frequency band >3GHz
      * Further study the maximum downlink RS-EPRE for 40MHz bandwidth for the above frequency bands

*In RAN4#98e:*

* + **PRS-EPRE-MAX** for band frequency <3GHz, 40MHz bandwidth
    - [-77dBm/30kHz] (starting point)

Note: This value is pending on further verification and confirmation from TE vendors/Test labs for the feasibility. Further discuss and revise the value is not excluded

*Further proposal on this topic is provided in this meeting:*

**Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz**

* Proposals
  + Proposal 1: define PRS-EPRE-MAX based on practical measurement for FR1.
* Recommended WF
  + TBA

**Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**

* Proposals
  + Option 1: -80dBm/15kHz (or equivalent -77dBm/30kHz)
  + Option 2: -79dBm/15kHz (or equivalent -76dBm/30kHz)
  + Option 3: based on practical measurement for FR1
* Recommended WF
  + TBA

**Issue 2-1-3: PRS-EPRE-MAX for FR2**

* Proposals
  + Proposal 1: further study how to specify PRS-EPRE-MAX for FR2
* Recommended WF
  + TBA

### Sub-topic 2-2 Figure of Merit for FR1

**Issue 2-2: Restriction of Pmode at 90%TP for 10MHz and 40MHz CHBW**

* Proposals
  + Proposal 1: adopt 2 of total 12 as additional restriction of Pmode at 90%TP for 10MHz and 40MHz CHBW.
* Recommended WF
  + TBA

### Sub-topic 2-3 Figure of Merit for FR2

**Issue 2-3-1: revision on the definition of MACS calculation**

*Moderator: 7 contributions are received, including 2 TPs (R4-2107295, R4-2107363) and 5 discussion paper (R4-2107116, R4-2106568, R4-2106272, R4-2105169, R4-2104513). To facilitate the discussion, moderator tries to summarize companies’ views into 3 options.*

* Proposals
  + Option 1: the final MASC is the average of the top 18 points.
    - Opt-1a: the number of missing points should not exceed 18
    - Opt-1b: the allowed number of missing points is FFS, at least should not exceed 18
    - Opt-1c: the allowed number of missing points is FFS
  + Option 2: the final MASC is the average of the best N sensitivity values. N=⌊M%\*36⌋, M is the percentile rank used in the EIS spherical coverage requirement of the DUT and the total number of test points.
    - Opt-2a: the number of missing points should be less than 36-N
    - Opt-2b: the allowed number of missing points is FFS, at least should not exceed 36-N
  + Option 3: the final MASC is the average of the top 50% points. when some points do not reach 70% maximum throughput, these points will not be considered in the CCDF and N is less than 18.
* Recommended WF
  + TBA

**Issue 2-3-2: additional criterion of FR2 FoM**

* Proposals
  + Proposal 1: For TP@70%, the number of missing points should be defined. (see issue 2-3-1 for details)
  + Proposal 2: TP@90% is also regarded as an additional FoM and the allowed number of missing points is FFS.
  + Proposal 3: Further check the final number of missing points allowed for FR2 MIMO OTA after the testing parameter are fully defined.
* Recommended WF
  + TBA

### Sub-topic 2-4 Framework on FR2 performance evaluation

**Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment**

* Proposals
  + Proposal 1: RAN4 should start the simulation campaign to calibrate the simulation platform with the channel model assumptions specified in TR38.827 as the first step.
  + Proposal 2: Companies should analyse the impact on the channel validation criterion such as PSP, PDP, doppler etc., and performance difference caused by the channel parameters variation such as AoA/ZoA, PAS, power, delay, etc. those explicitly reflect in the channel model parameters.
  + Proposal 3: The input on variation range of channel model parameters such as AoA/ZoA, PAS, power, delay, etc. impacting by 6 probes should be provided by TE/CE vendors.
* Recommended WF
  + TBA

### Sub-topic 2-5 FR2 simulation assumption

**Issue 2-5-1: simulation assumptions for FR2**

* Proposals
  + Proposal 1: propose to use the following assumptions for simulation campaign, i.e., using the channel parameters specified TR38.827 as the starting point:
    - UE antenna array: two panels 2x2 patches (option 1)
    - UE antenna parameters and Beam forming: Follow TR 38.803 (option 1)
    - Polarization alignment: polarization aligned between UE and TE (option 1)
* Recommended WF
  + TBA

**Issue 2-5-2: 40dB threshold for cluster power**

* Proposals
  + Proposal 1: 40dB threshold does not affect UE throughput performance with CDL-A InO channel model for FR2.
  + Proposal 2: Further discuss the necessity of CDL-A InO channel model for FR2 MIMO-OTA.
  + Proposal 3: CE vender are welcome to publish their probe weights and align them to reduce MU for FR2 MIMO OTA
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

**Sub topic 2-1 Maximum downlink RS-EPRE**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz**  As previous email discussion, the appropriate maximum downlink RS-EPRE is highly related to the output/input capability of the test equipment and the placement of the test labs. We would like to keep the previous WF that make -80dBm/15kHz as a starting point, then modify the PRS-EPRE-MAX based on the practical experience.  **Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**  Similar view with Issue 2-1-1. The starting point can be Option 1 or Option 2.  **Issue 2-1-3: PRS-EPRE-MAX for FR2**  Support P1. We believe further study on this topic needed at current stage. |
| vivo | **Issue 2-1-1:** Practical power validation results at typical low/mid/high bands are encouraged to check the feasibility of the agreed -80dBm/15kHz.  **Issue 2-1-1:** no strong view on Option 1 or Option2. Some demonstration results would be desirable to make the decision. |
| Samsung | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz**  Agree with previously agreed starting point -80dBm/15kHz and feasibility to be verified by practical measurement.  **Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**  Antenna directivity is becoming severe for higher frequency, more missing points are probably occur with Option 1 or 2. It is fine to start with the values in option 1 or 2, but feasibility is supposed to be verified by practical measurement  **Issue 2-1-3: PRS-EPRE-MAX for FR2**  As a proponent of Proposal 1, we think it is also necessary to specify maximum downlink power for FR2. |
| CAICT | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz**  Keep PRS-EPRE-MAX =-80dBm/15kHz as the starting point, and further study the feasibility of this value based on the practical experience.  **Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**  Prefer option 1 as starting point. And further check the feasibility based on practical measurement.  **Issue 2-1-3: PRS-EPRE-MAX for FR2**  Support P1. Further study is needed. |
| Huawei, HiSilicon | **Issue 2-1-1: we suggest to keep previous agreement (starting point) of [-77dBm/30kHz], i,e. -80dBm/15kHz Encourage company to offer practical measurement for FR1.**  **Issue 2-1-2: Prefer option 2 as taking into account the higher insertion loss.**  **Issue 2-1-3: PRS-EPRE-MAX for FR2**  **PRS-EPRE-MAX** for FR2 is unlike FR1, it relates to spherical coverage implementation. If UE concentrates on strong antenna gain in some directions and beam ‘front to rear ration’ is high, then UE requires for higher PRS-EPRE-MAX to get >=70% TP, while for UEs with an averaged beam ‘front to rear ration’, the PRS-EPRE-MAX may be lower. It is not easy to judge which implementation is better, and how to define a proper **PRS-EPRE-MAX** may need further analysis based on these aspects. |
| Qualcomm | **Issue 2-1-1:** We are OK with -80dBm/15kHz as the starting point and modify the PRS-EPRE-MAX if needed in future.  **Issue 2-1-2:** prefer option 2.  **Issue 2-1-3:** OK with proposal 1. |
| Xiaomi | **Issue 2-1-1:** We are OK with the proposal that to define the PRS-EPRE-MAX by practical measurement.  **Issue 2-1-2:** If the **PRS-EPRE-MAX** will be defined based on practical measurement for <3GHz case, we prefer similar approach for >3GHz case.  **Issue 2-1-3:** We are OK with moderator’s proposal 1. |

**Sub topic 2-2 Figure of Merit for FR1**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support the proposal as tentative agreement with square bracket. Given this is also applied to high band with 40MHz, we would like to conclude the final decision during the performance discussion stage with more measurement results of real UE and clear understanding of Maximum downlink power supported by the system at each band. |
| Samsung | We share exactly the same understanding as vivo. Support Proposal 1 as tentative agreement with square bracket |
| CAICT | Echo vivo’s comments. |
| Huawei, HiSilicon | Support proposal 1 |
| Xiaomi | Agree with VIVO. |
| OPPO | Support vivo’s proposal. |

**Sub topic 2-3 Figure of Merit for FR2**

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| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-3-1: revision on the definition of MACS calculation**  Support Opt 1b. As specified in WID that “Smartphone is the first priority”, which is PC3 UEs for FR2, M=50%, N=18, Option 2 has the same FoM with Option 1 according to PC3 UEs. |
| vivo | **Issue 2-3-1:** given there is additional criterion on the number of missing points, so we think Opt-1a-1c are not necessary. We support to average the top 18 points to keep the averaging process consistency among different UEs, in case the situation appears that UE with more missing points has a better averaged MASC.  Option2: For the averaging process of other power class, we need further discussions on whether the percentile selected for FR2 MIMO OTA needs to align with EIS spherical coverage performance. We are not clear about the direct dependency between EIS and MASC.  **Issue 2-3-2:** support P1 and P3. Regarding setting 90%TP as the FoM for FR2, we think more discussion is needed. |
| MediaTek | **Issue 2-3-1: revision on the definition of MACS calculation**  Echo OPPO’s comment on PC priority, we also prefer to finalize PC3 discussion firstly to avoid possible confusion and to make the discussion easier.  In this cases, these options actually have some common part from PC3 only view, as shared by OPPO. It may be easier to achieve consensus.  One clarification question on opt-1a/b/c about “allowed number of missing point”. Does it mean “the allowed number of missing points among the selected top 18 points of PC3”? For example, if the allowed number of missing points is 3. Does it mean 15 of top 18 of total 36 will be used to calculate MACS in the end?  If our above understanding is correct, the number is not possible to exceed 18, and then, the option-1-a/b/c are actually same.  **Issue 2-3-2: additional criterion of FR2 FoM**  We prefer to focus on TP@70% firstly, as agreed in prior WF R4-2017585, which will be easier to achieve consensus. |
| Samsung | **Issue 2-3-1: revision on the definition of MACS calculation**  Generally we are supportive to update the definition of MACS, and we can see these options focus on the same issue. We think it is beneficial for clear understanding by using “top 50% points” instead of “CCDF”. And for the top 50% points, if there are missing points allowed within, a substitution approach can be considered.  We think opt-1c should be kept before FR2 maximum downlink power configuration is specified. We can struggle to achieve the missing points number<=18, but if the maximum downlink power is not high enough, <=18 missing points can not be guaranteed.  **Issue 2-3-2: additional criterion of FR2 FoM**  We support P1 and P3. Regarding P3, we share similar view with vivo and MediaTek to focus on TP@70% firstly. |
| CAICT | **Issue 2-3-1: revision on the definition of MACS calculation**  We support opt-1b. If only PC3 UEs are considered as this stage, we believe option 1 and option 2 are the same.  To MTK:  From my understanding, “allowed number of missing points” means “the allowed number of missing points among the total 36 points”. That is, in addition to using the selected 18 points to calculate MASC, there is still an additional criterion on the number of orientations that cannot reach the target throughput (e.g. 70%).  For example, if the allowed number of missing points is 15, it means select top 18 of total (36-15) points to calculate MASC. If the EUT has 16 missing points, then the EUT shall fail the FR2 MIMO OTA test regardless of the MASC value calculated by top 18 points. Regarding opt-1c, if the allowed number of missing points is larger than 18, it means the similar substitution approach as FR1 MIMO OTA need be used to replace the missing point.  **Issue 2-3-2: additional criterion of FR2 FoM**  Support P1, P2, P3.  For FR1 MIMO OTA, the addition criterion is how many Pmode could reach the 70%TP and 90%TP. Similarly, FR2 MIMO OTA should also consider the restriction of Pmode other than at 70% TP. |
| Huawei, HiSilicon | **Issue 2-3-1: revision on the definition of MACS calculation**  We support option 1c. Firstly, the WI is prioritized on power class 3 requirement definition, we prefer to focus on PC3 currently. With 50% spherical coverage of PC3, the final MASC is the average of the top 18 points. For the allowed number of missing points, it may relate to the definition of FR2 max downlink RS-EPRE, so we propose it as FFS now. and it is natural to make “whether taking missing point into consideration” as FFS.  We have a TP on this topic, we volunteer to capture the agreement into our TP if there is any. |
| Qualcomm | **Issue 2-3-1:** We support option 2 (OK with 2a or 2b). Compared with option 1, option 2 is a general definition of MACS for all the power classes. We agreed to 50% which is the EIS rank for PC3. We’re OK to further discuss the value N for other PCs. But we think wring the spec in a general manner is preferable which would not make much change when the requirements of other UE power classes are introduced in the spec. We can add the statement in our TP like for PC3, M=50, while for other UE power class, M is FFS. It is more general way to define MACS for all the UE power classes.  The changes would be like this:  “  …  Such that {PM%-tile,70,1, …, PM%-tile,70,N} are the best N sensitivity values. N is determined by M, ~~the percentile rank used in the EIS spherical coverage requirement of the DUT and total 36,the number of test points. For example,~~ M is 50 for PC3 DUT. For other power class DUT, M is FFS.  …” |
| Xiaomi | **Issue 2-3-1: revision on the definition of MACS calculation**  We support option 1-c. For the missing point requirement, we need to consider together with the downlink RS-EPRE. Further to consider if the substitution method can be applied when the missing points are larger than 18.  **Issue 2-3-2: additional criterion of FR2 FoM**  We support P1 and P3. At least not to consider 90% at this stage. |

**Sub topic 2-4 Framework on FR2 performance evaluation**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | Issue 2-4-1: On Proposal 3, once the reference curves have been agreed, this range can be provided |
| MediaTek | **Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment**  Generally speaking, we think the intention of proposal 2&3 are fine, it would make the simulation result can be more aligned and accurate. |
| Huawei, HiSilicon | **Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment**  For proposal 1, we prefer to initiate the real simulation work after parameters related to TE/CE implementation is provided. Start the simulation campaign with channel models in TR 38.901/827 is not  For proposal 2 and 3, we prefer TE vendors to provide a reference probe weights for the 6 probes to facilitate the gap between measurement and simulation. Variation range of channel model parameters such as AoA/ZoA, PAS, power, delay actually not directly reflect the impact introduced by the probes and it makes the simulation more difficult. |
| Qualcomm | **Issue 2-4-1:** we support the proposals. RAN4 should start the simulation alignment as soon as possible. With P2&P3, companies can evaluate the SINR difference between ideal and realistic channel modelling. Otherwise, we could not make any process for FR2 MIMO OTA requirements. |

**Sub topic 2-5 FR2 simulation assumptions**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | Issue 2-5-2: cannot support Proposal 3 since the exact probe weights are proprietary |
| vivo | **Issue 2-5-2:** FR2 UMi CDL-C has been selected as the single channel model for FR2 MIMO OTA requirements, we suggest to focus on the simulation and test efforts on this channel model. However, if companies would like to provide results with other channel models (e.g. CDL-A InO), we believe this is contribution driven. |
| MediaTek | **Issue 2-5-1: simulation assumptions for FR2**  There is already agreement in the latest WF (R4-2103915) about UE antenna array:  *“All options can be taken for simulation, in which OP1 and OP2 are with high priority*  *Op1: two panels 2x2 patches*  *Op2: two panels 1x4 patches*  *Op3: three panels 2x2 patches*  *Op4: three panels 1x4 patches”*  If company prefer to have only one UE antenna array type, we prefer 1x4 patches.  Polarization alignment  　We also think the study is important. |
| Samsung | **Issue 2-5-1: simulation assumptions for FR2**  UE antenna array: we also prefer 1x4 patches if down-selection is needed.  Polarization alignment: if only consider polarization aligned between UE and TE (option 1), should the simulated performance be over-estimated than practical measurement? |
| Huawei, HiSilicon | **Issue 2-5-1: simulation assumptions for FR2**  For polarization alignment, Option 1 is the best case, and we need to further consider the polarization mismatch case when defining the requirement.  **Issue 2-5-2: 40dB threshold for cluster power**  For Proposal 2, the power distribution of clusters in CDL-A InO channel model is too concentrated, causing the three clusters at the same location to have very high power, and other clusters have almost no impact on UE throughput, which makes the CDL-A InO channel model look like the TDL channel model without angular spread. We would like to know the opinions of companies on CDL-A InO channel model for FR2 MIMO-OTA.  For Proposal 3, we prefer TE vendors to provide at least a reference probe weight to facilitate the simulation work, which is mentioned in Issue 2-4-1. |
| Qualcomm | **Issue 2-5-1:**  Clarification on the proposal 1. The proposal is not for the UE requirements definition but for the simulation calibration as the first step. Companies should submit the simulation results with the same assumptions to calibrate the simulation results and analyse the effect of channel modelling difference between real and ideal cases.  We are open to further discuss/down select the from the options when discussing the requirements. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2107363  (TP) | Moderator: R4-2107363 and R4-2107295 are on the same topic. It is recommended to focus on the open issues of FR2 FoM in Sub-topic 2-3 first, before going into TP discussion. |
| Qualcomm: Are the companies OK with the following change for R4-2107363?  “  …  Such that {PM%-tile,70,1, …, PM%-tile,70,N} are the best N sensitivity values. N is determined by M, ~~the percentile rank used in the EIS spherical coverage requirement of the DUT and total 36,the number of test points. For example,~~ M is 50 for PC3 DUT. For other power class DUT, M is FFS. |
|  |
| R4-2107295  (TP) | Moderator: R4-2107363 and R4-2107295 are on the same topic. It is recommended to focus on the open issues of FR2 FoM in Sub-topic 2-3 first, before going into TP discussion. |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic 2-1 Maximum downlink RS-EPRE** | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz**  *Agreement:*   * Keep the previously agreed starting point -80dBm/15kHz and modify the PRS-EPRE-MAX basedon practical measurement in the future if needed.   *Recommendations for 2nd round:*  *None.*  **Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**  *7 companies share views on this issue. 3 of them can accept either option 1 or option 2.*  *Tentative agreements:*   * *Adopt option 1 or option 2 as starting point, and further check the feasibility based on practical measurement.*   *Candidate options for the starting point:*   * *Option 1:* *-80dBm/15kHz (or equivalent -77dBm/30kHz)* * *Option 2: -79dBm/15kHz (or equivalent -76dBm/30kHz)*   *Recommendations for 2nd round:*  Further discuss this topic. Make decision on the starting points for PRS-EPRE-MAX for FR1 band frequency >3GHz. Agreement can be captured in the WF.  **Issue 2-1-3: PRS-EPRE-MAX for FR2**  *Agreements:*   * Further study how to specify PRS-EPRE-MAX for FR2   *Recommendations for 2nd round:*  None. |
| **Sub-topic 2-2 Figure of Merit for FR1** | **Issue 2-2: Restriction of Pmode at 90%TP for 10MHz and 40MHz CHBW**  *Agreements:*   * Adopt [2] of total 12 as additional restriction of Pmode at 90%TP for 10MHz and 40MHz CHBW. Conclude the final decision during the performance discussion stage.   *Recommendations for 2nd round:*  None. |
| **Sub-topic 2-3 Figure of Merit for FR2** | **Issue 2-3-1: revision on the definition of MASC calculation**  *8 companies shared views on this issue.* *The consensus is that the “top N points” should be used instead of the concept of “CCDF”.*  *The open issue is whether the definition of MASC calculation should only focus on PC3 at this stage or should be defined in a more general way so that it can be easily expanded to cover all UE power class.*  *Tentative agreements:*   * *Using the MASC is the average of “top N points” instead of “all the values better than 50% percentile of CCDF”. The specific wording can be further refined in 2nd round.*   *Candidate options:*   * Option 1: N=18 * Option 2: N=M%\*36. M is 50 for PC3 DUT. For other power class DUT, M is FFS.   *Recommendations for 2nd round:*  Further discuss on this topic. New Tdoc for a merged TP would be requested to reflect the conclusion of this topic if needed.  **Issue 2-3-2: additional criterion of FR2 FoM**  *5 companies shared views on this issue. 4 companies support to focus on 70%TP at this stage, 1 company pointed out that TP@90% should also be regarded as an additional FoM. Compromise on this disagreement is encouraged，therefore, the recommend agreement would be:*  *Agreements:*   * + For TP@70%, the allowed number of missing points should be defined, the specific number is FFS. Additional criterion (on other TP outage level) is FFS.   + Further check the final number of missing points allowed for FR2 MIMO OTA after the testing parameter are fully defined.   *Recommendations for 2nd round:*  None. |
| **Sub-topic 2-4 Framework on FR2 performance evaluation** | **Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment.**  *A tentative agreement is not yet clear at the moment.*  *Candidate option:*   * *Option 1:* * *Companies should analyse the impact on the channel validation criterion such as PSP, PDP, doppler etc., and performance difference caused by the channel parameters variation such as AoA/ZoA, PAS, power, delay, etc. those explicitly reflect in the channel model parameters.* * *The input on variation range of channel model parameters such as AoA/ZoA, PAS, power, delay, etc. impacting by 6 probes should be provided by TE/CE vendors.* * *Option 2:(raised by Huawei during the 1st round discussion)* * *TE vendors to provide a reference probe weights for the 6 probes to facilitate the gap between measurement and simulation.*   *Recommendations for 2nd round:*  Further discuss on this topic.Agreement can be captured in the WF. |
| **Sub-topic 2-5 FR2 simulation assumption** | **Issue 2-5-1: simulation assumptions for FR2**  *A tentative agreement is not yet clear at the moment.*  *Recommendations for 2nd round:*  further discuss the down selection of the options for simulation calibration. Agreement can be captured in the WF.  **Issue 2-5-2: 40dB threshold for cluster power**  *There is no objection on proposal 1 received.*  *Tentative agreements:*   * 40dB threshold does not affect UE throughput performance with CDL-A InO channel model for FR2.   *Recommendations for 2nd round:*  Further discuss the necessity of CDL-A InO channel model for FR2 MIMO-OTA. |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

### Sub-topic 2-1 Maximum downlink RS-EPRE

**Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**

*Candidate options for the starting point:*

* *Option 1:* *-80dBm/15kHz (or equivalent -77dBm/30kHz)*
* *Option 2: -79dBm/15kHz (or equivalent -76dBm/30kHz)*

*Recommendations for 2nd round:*

Further discuss this topic. Make decision on the starting points for PRS-EPRE-MAX for FR1 band frequency >3GHz. Agreement can be captured in the WF.

### Sub-topic 2-3 Figure of Merit for FR2

**Issue 2-3-1: revision on the definition of MACS calculation**

*8 companies shared views on this issue.* *The consensus is that the “top N points” should be used instead of the concept of “CCDF”.*

*The open issue is whether the definition of MASC calculation should only focus on PC3 at this stage or should be defined in a more general way so that it can be easily expanded to cover all UE power class.*

*Tentative agreements:*

* *Using the MASC is the average of “top N points” instead of “all the values better than 50% percentile of CCDF”. The specific wording can be further refined in 2nd round.*

*Candidate options:*

* Option 1: N=18
* Option 2: N=M%\*36. M is 50 for PC3 DUT. For other power class DUT, M is FFS.

*Recommendations for 2nd round:*

Further discuss on this topic. New Tdoc for a merged TP would be requested to reflect the conclusion of this topic if needed.

### Sub-topic 2-4 Framework on FR2 performance evaluation

**Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment**

*Candidate option:*

* *Option 1:*
* *Companies should analyse the impact on the channel validation criterion such as PSP, PDP, doppler etc., and performance difference caused by the channel parameters variation such as AoA/ZoA, PAS, power, delay, etc. those explicitly reflect in the channel model parameters.*
* *The input on variation range of channel model parameters such as AoA/ZoA, PAS, power, delay, etc. impacting by 6 probes should be provided by TE/CE vendors.*
* *Option 2:(raised by Huawei during the 1st round discussion)*
* *TE vendors to provide a reference probe weights for the 6 probes to facilitate the gap between measurement and simulation.*

*Recommendations for 2nd round:*

Further discuss on this topic.Agreement can be captured in the WF.

### Sub-topic 2-5 FR2 simulation assumption

**Issue 2-5-1: simulation assumptions for FR2**

*Recommendations for 2nd round:*

further discuss the down selection of the options for simulation calibration. Agreement can be captured in the WF.

**Issue 2-5-2: 40dB threshold for cluster power**



*Recommendations for 2nd round:*

Further discuss the necessity of CDL-A InO channel model for FR2 MIMO-OTA.

**Sub topic 2-1 Maximum downlink RS-EPRE**

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| --- | --- |
| **Company** | **Comments** |
| MVG | Issue 2-1-2: We are fine with either options. No matter the agreed option we must not preclude to  *check the feasibility based on practical measurement.* |
| Qualcomm | Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz  Option 2. |
| CAICT | Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz  Prefer option 1.  In the absence of verification of practical measurement results, we do not want to develop different maximum downlink power for frequency bands <3GHz and >3GHz. If possible, a unified maximum downlink power value for FR1 will be more beneficial. We can start with option 1 and further check if option 2 or other options will be more suitable based on measurement results. |

**Sub topic 2-2 Figure of Merit for FR1**

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| **Company** | **Comments** |
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**Sub topic 2-3 Figure of Merit for FR2**

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| **Company** | **Comments** |
| Qualcomm | Issue 2-3-1: revision on the definition of MACS calculation  Option 2. The draft TP has been shared in the reflector. |
| CAICT | Issue 2-3-1: revision on the definition of MACS calculation  Support option 2. For PC3, option 2 is exactly the same as option 1, but Option 2 defines the MASC calculation from a more general perspective, which should be beneficial from a standard perspective. |

**Sub topic 2-4 Framework on FR2 performance evaluation**

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| **Company** | **Comments** |
| Qualcomm | Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment  Considering TE/CE vendors have concerns to disclose the details of 6 probe weights, we should go with option 1.  For option 1, there are two-step:  Step 1: Companies to align the simulator. Channel modeling parameters specified in TR38.827 are applied in the simulation. The simulation parameters such as UE antenna, UE beamforming and Polarization alignment assumptions should be in line among the companies for simulation alignment.  Step: Companies to analyse the impact of channel parameters variation such as AoA/ZoA, PAS, power, delay, etc. those explicitly reflect in the channel model parameters on the UE MIMO OTA performance. Need the following input from CE/TE vendor:   * Option 1: Could provide the variation range for AoA/ZoA, PAS, power, delay, etc. those impacting by 6 probes * Option 2: Could provide the variation range for PSP, PDP, doppler, etc those are used for channel model validation. In this case, it is still not clear how to set the channel modelling paraments in the simulation to emulate the gap between simulation vs measurement.   It would be very helpful if CE/TE vendors can clarify what’s the input can be provided. |

**Sub topic 2-5 FR2 simulation assumptions**

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| **Company** | **Comments** |
| Qualcomm | Issue 2-5-1: simulation assumptions for FR2  Down-select the following assumptions for **simulation alignment**:   * UE antenna: Option 1 * UE beamforming: Option 1 * Polarization alignment: Option 1   Issue 2-5-2: 40dB threshold for cluster power  Prefer to keep CDL-A InO channel model for FR2 MIMO-OTA in this stage and further study the necessity. |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on NR MIMO OTA | vivo, CAICT |  |
| TP to TS38.151: revision on MIMO Average Spherical Coverage | Qualcomm Incorporated, Huawei, HiSilicon , CAICT, vivo, OPPO |  |
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**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| [R4-2104510](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104510.zip) | TP to TS38.151 v0.2.0 on FR1 Channel model | vivo, CAICT | Revised | *Update to reflect the comments in 1st round* |
| [R4-2104511](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104511.zip) | TP to TS38.151 v0.2.0 on calibration and test procedure | vivo, CAICT | Agreeable |  |
| R4-2104512 | 3GPP TS 38.151 v0.3.0 | vivo | Return to | *reserved* |
| [R4-2104513](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104513.zip) | Discussions on FR2 FoM | vivo | Noted |  |
| [R4-2104514](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104514.zip) | Discussion on Power Validation procedure and compensation process | vivo | Noted |  |
| [R4-2104515](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104515.zip) | Updated workplan of MIMO OTA WI | vivo, CAICT, OPPO | Revised | *Update to reflect the comments in 1st round* |
| [R4-2105020](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105020.zip) | NR FR1 MIMO OTA Reference Spatial Correlation Curves based on Different Optimization Algorithm | CMCC | Noted |  |
| [R4-2105041](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105041.zip) | Discussion on channel model and downlink power configuration | Samsung | Noted |  |
| [R4-2105169](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105169.zip) | Testing parameters for Performance: "On remaining open issues of testing parameters for performance" | Huawei,HiSilicon | Noted |  |
| [R4-2105170](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105170.zip) | Optimization of test methodologies: "On Channel model for FR1 2x2 MIMO OTA requirements" | Huawei,HiSilicon | Noted |  |
| [R4-2106272](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106272.zip) | Views on how to treat the missing points for FR2 FoM | CAICT | Noted |  |
| [R4-2106567](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106567.zip) | Consideration on Spatial Correlation with combined beam | OPPO | Noted |  |
| [R4-2106568](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106568.zip) | FoM for FR2 | OPPO | Noted |  |
| [R4-2106569](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106569.zip) | Views on FR2 blocking issue | OPPO | Noted |  |
| [R4-2106902](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106902.zip) | Spatial Channel Model Validation Targets | Spirent Communications | Noted |  |
| [R4-2107116](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107116.zip) | Discussion on FR2 MIMO OTA performance requirements | Qualcomm Incorporated | Noted |  |
| [R4-2107126](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107126.zip) | On Blocking MU for FR2 MIMO OTA | Keysight Technologies UK Ltd, | Noted |  |
| [R4-2107127](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107127.zip) | Reference Channel Emulation Curves | Keysight Technologies UK Ltd | Revised | *Key technology update: update the reference results of the channel model verification* |
| [R4-2107174](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107174.zip) | Views on MU evaluation of FR2 blocking issue | CAICT | Noted |  |
| [R4-2107293](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107293.zip) | on channel bandwidth for NR FR2 MIMO OTA RMC | Huawei, HiSilicon | Noted |  |
| [R4-2107294](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107294.zip) | Discussion on FR2 MIMO OTA simulation | Huawei, HiSilicon | Noted |  |
| [R4-2107295](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107295.zip) | TP to 38.151 on MIMO Average Spherical Coverage | Huawei, HiSilicon | Not pursued | *new tdoc is requested to cover this topic* |
| [R4-2107363](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107363.zip) | TP to TS38.151: revision on definition for MASC | Qualcomm Incorporated | Not pursued |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
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2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents